PHA167

THE EFFECTS OF PESTICIDES AND NUTRIENT LOADINGS IN SOUTH FLORIDA CANALS ON *SELENASTRUM CAPRICORNUTUM* AND *DAPHNIA MAGNA*.

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ABSTRACT

Anthropogenic sources of nutrients and pesticides entering surface waters has been an issue of concern in South Florida for many years. The purpose of this study was to evaluate the response of two standard bioassay organisms to water samples from South Florida canals. Water samples were collected from 5 sites within the C111 canal system in the South Florida Water Management District. Sampling sites were chosen based on associated land-use activities: agricultural, urban/suburban, and undeveloped. These samples were shipped to the National Ocean Service in Charleston, SC and were analyzed for pesticide residues (endosulfan and chlorpyrifos). These samples were also evaluated for toxicity using *S. capricornutum* and *D. magna*. The endpoints used for *S. capricornutum* bioassays were direct cell counts and absorbance at 664nm. Endpoints for *D. magna* included mortality and suppression of enzyme activity. Gas chromatographic methodologies revealed detectable levels of pesticides from sites within the C111 drainage canal system. Existing data (US EPA) indicate a history of high nutrient levels at several of the sampling sites. *S. capricornutum* showed varying growth responses to the water samples. Samples collected from sites with agricultural influences had significantly greater growth rates than controls. Conversely, exposure to a sample collected near an urban/developed area caused a significant depression in growth. No significant effects on survival or suppression of enzyme activity were observed in *D. magna* following exposure to any of the water samples. Ecotoxicological problems involving pesticides and nutrient loads are quite complex. Our future research will utilize laboratory tests to better delineate the individual and combined effects of nutrient inputs and pesticide loading in South Florida.

INTRODUCTION

Water quality is an issue of major concern in South Florida. In recent years, water has been diverted from the Everglades to supply water to the city of Miami and surrounding suburban and agricultural areas. This water is drained into a series of man made canals after use. Some of these canals ultimately drain into Barnes Sound at the northeastern corner of Florida Bay. This runoff contains a variety non-point source pollutants such as pesticides (Scott et al. 1994) and nutrients (NOAA, 1996). The objective of this study was to examine the response of two standardized toxicity test organisms to canal surface water collected in February 1998 from five sites. The organisms used were the freshwater phytoplankton species *Selenastrum capricornutum* and the freshwater invertebrate *Daphnia magna*. Water samples were also collected in February 1998 for pesticide analysis of chlorpyrifos and endosulfan. Addtionally, a laboratory experiment was conducted to investigate potential interactions exists between endosulfan and varying amounts of nitrogen and phosphorus.

FIGURE 1: STUDY AREA

Sampling sites along the South Florida Canal System are shown using pink dots and corresponding blue letters.

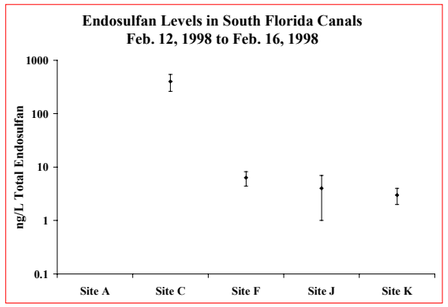
METHODS

- Water samples were collected from five sites within the South Florida Water Management District's canal system (Figure 1). Land use characteristics:
  - Site A - Everglades, Agriculture, undeveloped
  - Site C - Heavy Agriculture
  - Site F - Downstream from site C, undeveloped
  - Site J - Suburban, Some agriculture
  - Site K - Suburban, Some agriculture
- Samples from Sites A,C, and F were collected on 12 Feb. 1998. Additional samples from Sites A,C,F,J, and K were collected on 16 Feb. 1998.
- Standardized culturing methods and toxicity test methods were used for *Selenastrum capricornutum* (ASTM, 1996). Treatment groups were compared using One-Way Anova (α=0.05).
- The Daphnia IQ test™ (Aqua Survey, Inc.) was used to evaluate the toxic potential of water samples. Treatment groups were compared using One-Way Anova (α=0.05). The IQ test measures the fluorescence of a specific fluorgenic substrate cleaved by healthy organisms during a specific enzymatic reaction.
- Samples for toxicity tests were shipped via next day air to the National Ocean Service's Charleston Laboratory and tests were initiated within 24 hours of sample collection.
- Grab water samples for pesticide analysis were collected and extracted using C18 solid phase extraction. These water samples were eluted and then analyzed for chlorpyrifos and endosulfan using dual column GC-ECD.
- Laboratory experiments with nutrient and endosulfan manipulations were conducted using *S. capricornutum* (Table 1). Nutrient concentrations approximated environmental relevent low and high levels of nitrogen and phosphorus. The endosulfan concentration used was equivalent to the EC50 for *S. capricornutum* (DeLorenzo et al. 1998. see PHA166).

RESULTS

- ***S. capricornutum* results:**
  - For samples collected 12 Feb. 1998, Site C had significantly greater growth ($p<0.05$) than the media control (Figure 2a).
  - For samples collected 16 Feb. 1998, Sites A and C had signficantly greater growth ($p<0.05$) than the media control. Conversly, Site J showed signicantly lower growth ($p<0.05$) than the media control (Figure 2b).
- ***D. magna* results:**
  - There was no statistically significant difference ($p>0.05$). between treatment groups for *D. magna* at either sampling date in terms of fluorescence (Figures 3a & 3b) or mortality (not shown).
- **Pesticide Residue Analysis:**
  - No samples contained detectable levels of chlorpyrifos.
  - 89.7% (26 of 29) of samples collected contained detectable levels of total endosulfan. Concentratons ranged from <1 to 1038 ng/L. Site C (Figure 4) had the highest mean level of total endosulfan at 400.2 ng/L (std. error = 139.2 ng/L, n=6). Site A had no detectable level of endosulfan (n=2).
- **Laboratory Endosulfan/Nutrient Interaction Experiment:**
  - *S. capricornutum* showed significantly depressed ($p<0.05$) growth in endosulfan (428µg/L) treatments with high phosphorus (0.185mg/L) (Figure 5).

FIGURE 4: Endosulfan Residue Analysis

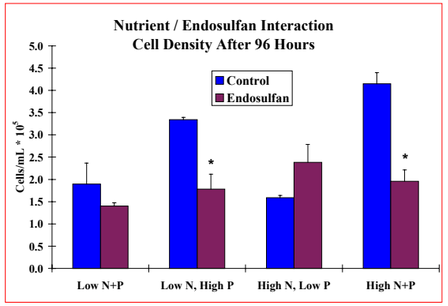


Site C had the highest levels of endosulfan ranging from <1 to 1038 ng/L. Site C had a mean concentration of 400ng/L (n=6), this is about 1000 times less than the 96 hour EC50 for *S. capricornutum*.

TABLE 1: Endosulfan/Nutrient Interaction Experimental Design

Treatment	Control	428µg/L endosulfan
Low N Low P	0.042 mg/L 0.00185 mg/L	0.042 mg/L 0.00185 mg/L
Low N High P	0.042 mg/L 0.185 mg/L	0.042 mg/L 0.185 mg/L
High N Low P	4.2 mg/L 0.00185 mg/L	4.2 mg/L 0.00185 mg/L
High N High P	4.2 mg/L 0.185 mg/L	4.2 mg/L 0.185 mg/L

FIGURE 5: Laboratory Study with *S. capricornutum*.



Control groups with high P levels showed greater levels of *S. capricornutum* growth. In each of the high P treatments, endosulfan significantly reduced growth when compared to controls.

CONCLUSIONS

- Over the time course of this study, nutrients appeared to play a greater role in affecting the growth of *S. capricornutum* than endosulfan in South Florida Canal water samples. Thus, concern is raised about the possibility of increased nutrient effects on natural phytoplankton communities.
- The highest endosulfan levels detected (Site C) are about three orders of magnitiude lower than the 96 hour EC50 for *S. capricornutum.*
- Suburban runoff may pose potential risk to freshwater phytoplankton based on the results in Figure 2b from Site J. Many different compounds are known to be present in suburban runoff (pesticides, PAHs, and metals). Thus, the problem is quite complex in this case and it is most likely that effects observed are due to multiple factors.
- A two-way ANOVA from the laboratory endosulfan/nutrient interaction experiment indicated that a significant interaction ($p=0.0004$) existed between endosulfan concentration and nutrient concentrations for growth of *S. capricornutum*. A one-way ANOVA ($p=0.004$) on just the controls (nutrient treatments without endosulfan) indicated that those treatments with high P had significantly greater growth than those with low P. Thus, *S. capricornutum* appears to be more P limited than N limited.
- In each of the high P treatments, endosulfan significantly reduced growth of *S. capricornutum* when compared with a t-test to their respective controls ($p<0.05$), however the concentration used in this experiment was 1000 fold greater than the mean endosulfan level found at Site C.
- FURTHER RESEARCH
  - The extent to which nutrient loadings occur in South Florida should be examined in detail.
  - Phytoplankton and microbial species should be observed to determine if possible community shifts occur due to increased nutrient loads and pesticide exposure.
  - Subsequent effects on invertebrate grazers should also be studied both in terms of bioaccumulation potential of pesticides and shifts in the quality (nutritive value) of their food source.

S. capricornutum

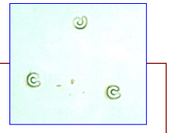


FIGURE 2a

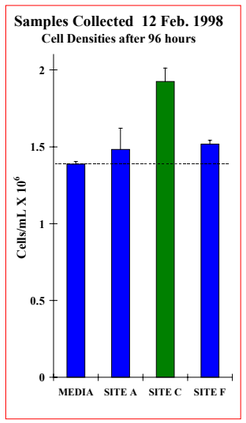
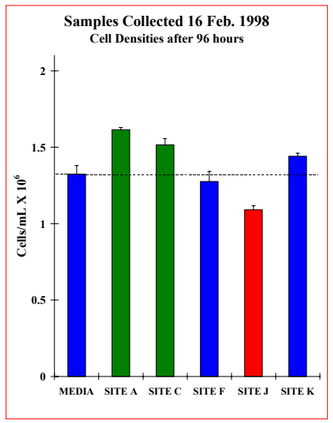


FIGURE 2b



Site C showed stimulated growth of *S. capricornutum* for samples collected on 12 Feb. 1998. Sites A and C showed stimulated growth for samples collected on 16 Feb. 1998. Site J showed a decrease in growth. Site J has an associated suburban land use and is less likely to receive heavy nutrient loadings and more likely to receive suburban non-point source runoff.

D. magna

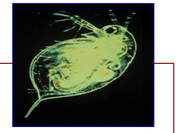


FIGURE 3a

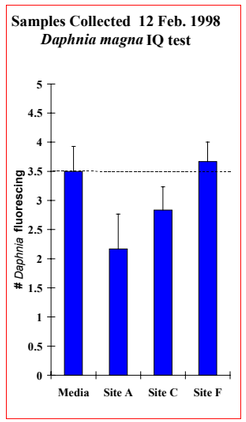
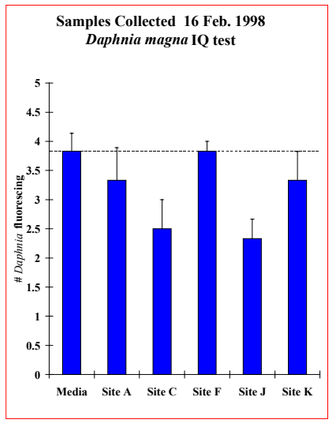


FIGURE 3b



There was no significant difference in enzymatic activity of *D. magna* among the different sites tested for both sampling dates.